Genetic Stock Identification of Kuskokwim River Chinook Salmon *Oncorhynchus tshawytscha*

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Introduction

Currently, Kuskokwim River salmon are commercially harvested in the mainstem as a mixed-stock fishery. Commercial openings target specific species but no attempt is made to manage for individual stocks of each species. Chum salmon *Oncorhynchus keta* is the primary species targeted in the commercial fishery but chinook salmon played an important role in the recent past.

Prior to 1987, chinook salmon were harvested in both the commercial and subsistence fisheries. Average annual combined chinook salmon catches from 1960 to 1969 and 1970 to 1979 were 52,300 and 78,648 fish, respectively. Although catches continued to increase through 1984, chinook salmon escapements began to decline and escapement indices were below management objectives (Alaska Department of Fish and Game 1985).

Gear restrictions were imposed in 1985 and 1986 but failed to change the trend in declining escapements. In 1987, the chinook salmon commercial fishery was eliminated to insure continued subsistence catches. Even though chinook salmon continued to be harvested incidentally in the commercial chum salmon fishery, overall Kuskokwim River chinook salmon escapement objectives were met in 1987, 1988, and 1989 for the first time since 1981 (Alaska Department of Fish and Game 1989 and 1990).

In contrast, the recent change to a more conservative approach of managing the commercial harvest of Kuskokwim River salmon seems to have had lesser effect on the escapement of chinook salmon stocks originating on the Yukon Delta National Wildlife Refuge. Chinook salmon escapements into the Kisaralik, Kasigluk, Kwethluk, and Tuluksak rivers have remained consistently below management objectives with the exception that the Kwethluk River met escapement in 1989 for the first time since 1979 (Alaska Department of Fish and Game 1990).

Reasons for the discrepancies in spawning escapements between refuge and non-refuge chinook salmon stocks are not completely understood. However, as long as non-refuge stocks continue to experience adequate escapements, and the overall Kuskokwim River escapement goal for chinook salmon continues to be met, it is not likely that efforts will be made to reduce the incidental interception rate of chinook salmon in the chum salmon commercial fishery. As a result, refuge chinook salmon stocks will probably continue to be intercepted in the chum salmon commercial fishery at existing rates and will continue to experience underescapement.

The Alaska National Interest Lands Conservation Act (Alaska Lands Act) requires that salmon populations on the Yukon Delta National Wildlife Refuge be conserved in their natural diversity. If chinook salmon stocks in these rivers continue to experience underescapement, the Alaska Lands Act requirements may not be satisfied. The Refuge Fishery Management Plan, Refuge staff, and Commercial Fisheries Division

of Alaska Department of Fish and Game (Department) have identified this problem as one of the most important fisheries concerns on the Refuge (U.S. Department of the Interior, U.S. Fish and Wildlife Service, *In review*).

Chinook salmon stocks in other drainages exhibit distinct differences in run timing with those migrating the farthest upstream arriving at the river mouth the earliest (Scott and Crossman 1973). Since non-refuge chinook salmon migrate and spawn farther upstream in the Kuskokwim River than refuge chinook salmon, it is possible that some difference in run timing may exist between these two groups. If a difference in run timing could be determined, fishing effort could be reduced during that period when refuge chinook salmon would be the most vulnerable to interception.

With this idea in mind, a pilot project was conducted in 1989 to examine the feasibility of using a fish tagging program to determine if refuge and non-refuge chinook salmon enter the lower Kuskokwim River at different times. A total of 320 chinook salmon were tagged and 84 tag recoveries were made. Seventy-six of the recovered tags were taken from the commercial and subsistence fisheries. Only one tag was recovered in a refuge tributary stream. It was concluded that tagging was not a feasible approach without expanding the project considerably (Marino and Otis, *In review*).

An alternative recommended by the authors was to use genetic stock identification techniques to determine if refuge and non-refuge chinook

salmon are genetically distinct. If so, the mixed-stock fishery could be sampled to determine if the two stocks differ in run timing. Thus, a five-year project was designed by the Kenai Fishery Assistance Office to determine whether refuge and non-refuge chinook salmon differ in run timing using genetic stock identification techniques. The objectives of the study are: 1) to develop a genetic baseline for stock identification of lower Kuskokwim River chinook salmon populations originating in the Yukon Delta National Wildlife Refuge; 2) to develop a genetic baseline for stock identification of chinook salmon populations originating in the upper Kuskokwim River outside the refuge; 3) to determine whether sufficient detectable genetic divergence exists between refuge and non-refuge originating chinook salmon populations to permit accurate stock composition estimates in the mainstem Kuskokwim River mixed-stock fisheries; and 4) to determine if run timing differences occur between refuge and non-refuge originating chinook salmon stocks by sampling the mixed-stock fishery over the time period that chinook salmon enter the lower Kuskokwim River.

This document is a report of progress on the genetic stock identification of Kuskokwim River chinook salmon.

Study Area

The Kuskokwim River is the second largest river in Alaska. Its headwaters are on the western slope of the Alaska Range 1,094 km from its mouth. It drains the slopes of the Alaska Range and the Kuskokwim

Mountains and empties into the Bering Sea south of the Yukon River (Figure 1). The mean annual discharge over 32 years at Crooked Creek, upstream of the refuge, was 1,162 m^3/s with flows ranging from a high of 11,101 m^3/s in June 1964 to a low of 173 m^3/s in March 1966 (U.S. Department of the Interior, U.S. Fish and Wildlife Service 1988).

The Yukon Delta National Wildlife Refuge includes the lower 190 km of the mainstem, from the village of Aniak downstream (Figure 1).

Chinook salmon are distributed throughout the Kuskokwim River drainage. The mainstem is used as a migration corridor while spawning and rearing occurs in the clear water reaches of the tributary streams. Important chinook salmon spawning streams within the Yukon Delta National Wildlife Refuge include the Eek, Kwethluk, Kasigluk, Kisaralik, and Tuluksak rivers. Important spawning streams in the upper Kuskokwim River include the Aniak, Holitna, Kogrukluk, Chukowan, Hoholitna, Stony, Swift, and South Fork rivers, although spawning occurs in a number of other tributaries to a lesser extent as well (Alaska Department of Fish and Game 1986).

Samples of juvenile chinook salmon were collected from four tributary streams on the Yukon Delta National Wildlife Refuge (Kwethluk, Kasigluk, Kisaralik, and Tuluksak rivers) and five tributary streams located upriver from the refuge boundary (Chukowan, Kogrugluk, Hoholitna, Stony, and Swift rivers). Physical characteristics of these rivers are summarized in Table 1.

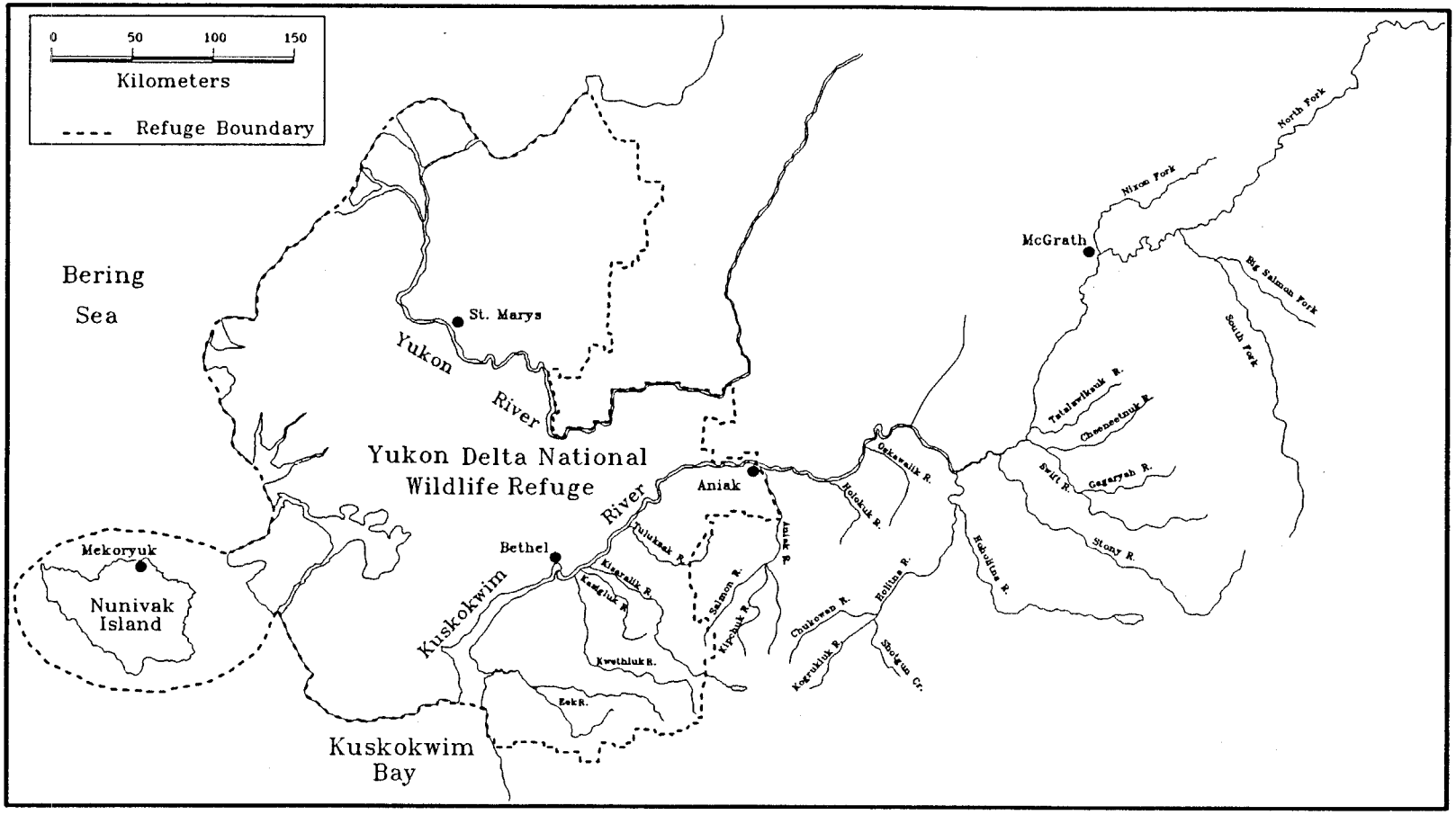

FIGURE 1.—Kuskokwim River drainage depicting the Yukon Delta National Wildlife Refuge and major chinook salmon spawning tributaries.

TABLE 1.–Physical characteristics of river systems where juvenile chinook salmon were collected, Kuskokwim River drainage, Alaska.

River	Length (km)	Drainage area (km^2)	Average channel gradient (m/km)	Elevation (m) Lowest	Elevation (m) Highest	Mean flow (m^3/s)	Distance from mouth of Kuskokwim River (rkm[a])
Kwethluk	222	3,367	2.5	12	579	30.7[b]	159
Kasigluk	97	1,023	4.4	12	427	6.8[b]	173
Kisaralik	177	3,807	3.0	12	488	23.0-39.0[c]	175
Tuluksak	145	2,256	2.8	12	427	10.9[b]	218
Chuckowan	48	1,839	1.5	122	198	33.7[d]	717
Kogrukluk	71	1,046	6.1	122	549	17.8[d]	717
Hoholitna	265	6,242	1.1	53	355	-	590
Stony	306	8,547	2.8	76	914	29.0-202.0[e]	587
Swift	169	6,268	4.9	84	914	-	611

[a] River kilometer.
[b] Average summer flow.
[c] Range of average summer flows (Alt 1977).
[d] Flow on Aug 6, 1985 (Alaska Department of Natural Resources, unpublished data).
[e] Range of low (winter) and high (summer) flows (Alaska Department of Natural Resources, unpublished data).

Methods

Sampling was conducted during July in 1990 and July and August in 1991. Juvenile chinook salmon were collected using minnow traps baited with salmon eggs and with short beach seines. The minnow traps were 43 cm long, 22.8 cm in diameter, and consisted of 6 mm mesh galvanized wire. The beach seines were between 4.5 and 6.0 m long, between 1.2 and 2.5 m deep, and consisted of 6 mm knotless nylon mesh.

Minnow traps were set out along shoreline areas where cover was readily available. Cover generally consisted of brush, logs, and other woody debris. Water depths ranged from 0.3 to 1.5 m. Minnow traps were generally fished overnight, usually 14 to 20 hours. Beach seines were used to sample a variety of habitats but were most effective over shallow gravel bars.

Juvenile chinook salmon were wrapped in plastic wrap, usually in groups of 20-30, sealed in marked plastic bags, and frozen whole in liquid nitrogen.

Results

A total of 1,908 juvenile chinook salmon were collected from Kuskokwim River tributaries for genetic stock identification during 1990 and 1991 (Table 2). Approximately 62% (N=1,189) of the juvenile chinook

TABLE 2.–Sampling locations and number of juvenile chinook salmon collected for genetic stock identification during 1990 and 1991.

River and site	Latitude	Longitude	Sample size	Collection date
Kwethluk River				
1	60°23.32'N	161°05.44'W	54	Jul 1990
2	60°19.35'N	160°55.48'W	60	Jul 1990
3	60°19.52'N	161°02.47'W	60	Jul 1990
4	60°21.61'N	161°05.59'W	76	Jul 1990
5	60°28.94'N	161°05.04'W	66	Jul 1990
6	60°30.30'N	161°05.06'W	47	Jul 1990
7	60°32.07'N	161°05.55'W	0	Jul 1990
Kasigluk River				
1	60°44.36'N	160°42.07'W	35	Jul 1990
2	60°46.50'N	160°47.32'W	200	Jul 1990
3	60°46.57'N	160°51.04'W	65	Jul 1990
4	60°47.49'N	160°54.25'W	60	Jul 1990
5	60°48.14'N	160°57.32'W	15	Jul 1990
Kisaralik River				
1	60°46.09'N	160°40.45'W	52	Aug 1991
2	60°46.04'N	160°38.39'W	52	Aug 1991
3	60°44.73'N	160°28.08'W	50	Aug 1991
4	60°44.17'N	160°22.16'W	30	Aug 1991
5	60°38.24'N	160°19.38'W	29	Aug 1991
Tuluksak River				
1	60°59.30'N	160°32.50'W	70	Jul 1991
2	60°59.80'N	160°33.50'W	80	Jul 1991
3	60°58.90'N	160°32.50'W	8	Jul 1991
4	61°00.10'N	160°34.60'W	80	Jul 1991
5	60°58.60'N	160°30.90'W	0	Jul 1991
Chukowan River				
1	60°49.86'N	157°58.32'W	30	Aug 1991
2	60°49.73'N	158°00.14'W	60	Aug 1991
3	60°50.74'N	158°09.73'W	30	Aug 1991
4	60°44.68'N	158°27.73'W	23	Aug 1991
Kogrugluk River				
1	60°49.12'N	157°51.74'W	20	Aug 1991
2	60°46.91'N	157°56.41'W	36	Aug 1991
3	60°44.03'N	158°03.45'W	39	Aug 1991
4	60°38.95'N	158°14.57'W	25	Aug 1991

TABLE 2.—Continued.

River and site	Latitude	Longitude	Sample size	Collection date
Hoholitna River				
1	61°17.64'N	156°46.45'W	49	Aug 1991
2	61°13.10'N	156°41.36'W	1	Aug 1991
3	61°12.45'N	156°40.29'W	11	Aug 1991
4	61°04.72'N	156°32.59'W	30	Aug 1991
5	60°57.27'N	156°04.89'W	18	Aug 1991
6[a]	60°50.49'N	156°12.56'W	64	Aug 1991
7	60°57.89'N	156°02.39'W	50	Aug 1991
Stony River				
1	61°03.80'N	154°22.65'W	0	Aug 1991
2	61°00.78'N	154°10.73'W	0	Aug 1991
3[b]	61°13.34'N	155°02.43'W	91	Aug 1991
Swift River				
1[c]	61°37.92'N	155°30.52'W	100	Aug 1991
2	61°29.79'N	155°11.60'W	0	Aug 1991
3[d]	61°33.86'N	154°51.71'W	42	Aug 1991

[a] Sample was collected in the South Fork of the Hoholitna River.
[b] Sample was collected in Can Creek, a tributary to the Stony River.
[c] Sample was collected in Gagaryah River, a tributary to the Swift River.
[d] Sample was collected in the North Fork of the Swift River.

salmon were collected at 22 sampling locations on refuge tributaries (Kwethluk, Kasigluk, Kisaralik, and Tuluksak rivers). The remaining 38% (N=719) were collected at 21 sampling locations on upper Kuskokwim River tributaries (Chukowan, Kogrukluk, Hoholitna, Stony, and Swift rivers).

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